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Exposure to UVB (290-320 nm) harms some aquatic taxa and processes. With the restoration of pre-industrial ozone levels still some years away and the possibility that climate change might lower dissolved organic matter (DOM) concentrations and thus lead to increased exposure, evaluating the extent to which freshwater environments in Canada are at risk is warranted. First, the distribution of a UVB-sensitive zooplankton genus, *Daphnia*, was examined as a function of DOM and maximum depth (Z_{max}) in 258 lakes and ponds in Ontario and the eastern U.S. to determine whether UVB exposure restricts its distribution. Our results indicate that the distribution of *Daphnia* is not restricted by exposure to UVB with the possible exception of very clear, shallow systems underrepresented in the surveys. Secondly, the maximum depth of UVB transmission (the depth at which 1% of surface irradiance at 320 nm occurs, $Z_{320,1\%}$) was compared to Z_{max} in over 900 aquatic systems in different Canadian ecozones to determine the proportion of optically clear systems ($Z_{max} < Z_{320,1\%}$) and the extent to which systems that are not clear may become so (at risk') should they lose 50% of their DOM. The proportion of systems deemed optically clear is low (<6%) across Canada with the exception of three ecozones between 13% and 20%. The proportion of systems deemed at risk is 0% in most regions with 5–9% in five regions from four ecozones. These results suggest that DOM levels are adequate to prevent large-scale loss of sensitive species from direct exposure to elevated UVB in most regions of Canada.

B34A CC: 524 A Wednesday 1530h

Interpreting Stable Isotope Measurements in Ocean Biogeochemistry: What Are We Learning?

Presiding: **K Denman,** Canadian Centre for Climate Modelling and Analysis**; R W Macdonald,** Institute of Ocean Sciences

B34A-01 1530h INVITED

Oceanic Nitrogen Isotope Biogeochemistry - A Status Report

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Nitrogen occupies redox states spanning -3 to +5 and is correspondingly subjected to a relatively large number of biogeochemical transformations with substantial potential for isotopic discrimination. In most settings, terrestrial or marine, many nitrogen cycle pathways are operating simultaneously. A reasonable a priori assumption could be that variations in N isotopic ratio would be difficult to interpret due to multiple influences. Several decades of study of oceanic patterns in 15N/14N (d15N), however, show that several aspects of marine N biogeochemistry result in the dominance of only several processes on present and past variations in d15N. This simplification results from 1) N in chemically combined form being a biologically limiting nutrient in much of the near-surface ocean and 2) physical separation of major transformation processes either as a function of depth or oceanographic region. Much of the large scale variation in d15N in the ocean is associated with processes directly influencing the d15N of dissolved nitrate (0 to 20 per mil range; 5 per mil average), the major form of combined N in the ocean. Denitrification of nitrate to N2 in suboxic intermediate waters has a large isotope fractionation factor (20 to 30 per mil) such that these regions have typically high d15N values. N2 fixation in oligotrophic gyres contributes combined N with d15N 1 to 2 per mil less than atmospheric N2 and results in decreased d15N for subsurface nitrate. Since nitrate is typically the predominant form of new nitrogen to oceanic phytoplankton, these large-scale variations in d15N are imprinted on organisms, the organic matter they produce, and ultimately the sediments. Sediment d15N has been shown to provide, for example, important records of past variations in water column denitrification. In HNLC regions where near-surface ocean nitrate is not completely consumed by phytoplankton, isotopic fractionation (5 to 8 per mil) during uptake is expressed as low d15N for plankton and increased d15N for nitrate as function of its degree of utilization. Trophic transfer and organic matter diagenesis can also alter d15N values but do not produce regional variations.

B34A-02 1550h

Sedimentary N Isotopes Dominated by Glacial-Interglacial Modulation of the Marine N Cycle

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Sedimentary nitrogen isotopes (δ^{15}N) have been most often interpreted as recorders of local biological parameters. However, numerous sedimentary δ^{15}N records compiled from widely distributed marine environments can be parsimoniously explained as reflecting, instead, the isotopic impact of broadly synchronous global changes in water column denitrification on glacial-interglacial cycles. Furthermore, other records display tantalizing evidence of synchronous response by N-fixation communities. We suggest that the spatial and temporal averaging achieved by sedimentation processes effectively eliminates any imprint of local ecosystem variability in most sedimentary environments, producing records that tend to integrate the isotopic signatures of regional fixed-N pools. A potential mechanism to explain the global coherence of the denitrification records involves a simple physical control on the flux of dissolved oxygen to suboxic zones, and the coupling to fixation via the supply of phosphorus to diazotrophs in suitable environments. Accordingly, lower glacial-stage sea surface temperature and greater sea-ice coverage in high-latitude regions increased oxygen solubility and probably enhanced the rate of intermediate-water formation, respectively. The resultant colder, rapidly circulating intermediate waters diminished the extent of denitrification and, consequently, N fixation. During warm periods, sluggish circulation of warmer, less oxygen-rich intermediate waters caused expansion of denitrification zones and a concomitant increase in N fixation. Local fluctuations in productivity due to variable atmospheric circulation patterns would have modulated this low frequency global signal.

B34A-03 1605h

Stable Isotopes in Sinking Particles: Answering two Questions at once

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The stable isotopic composition of organic matter in sinking particles reflects the source of the particles and the processes involved in their production. Both del C-13 and del N-15 are affected by the balance between terrigenous and marine organic matter. Del C-13 is also affected by productivity, while del N-15 varies with the length of the local aquatic food chain and with the availability of nutrients. Individually, the two isotopes do not necessarily provide a unique interpretation. However, by plotting del C-13 against del N-15 it is possible to understand that seasonal and spatial variations in sediment trap data collected over three years in the Strait of Georgia are due to changes in the composition of local phytoplankton and the relative proportion of marine- vs. terrigenous organic matter. The sinking organic matter can therefore be described as a mixture of three end-members - terrigenous, marine summer and marine winter. The techniques and observations described here are likely to be generally applicable to coastal waters with high local productivity and significant terrestrial run-off.

B34A-04 1620h

Oceanographic Controls on the Stable Carbon Isotopic Composition of Sinking particles and Surface Sediments in the Cariaco Basin.

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Stable carbon isotopic compositions of organic matter ($\delta^{13}C_{org}$) are used as a paleoproxy for aqueous CO_2 concentration and productivity, yet there are many variables which can influence the integrity of the signal created in the surface ocean. As part of the CARIACO Project we analyzed the $\delta^{13}C_{org}$ of sinking particles over the period extending from 1996-1999 in order to investigate the oceanographic and environmental variables which can affect the $\delta^{13}C_{org}$ as it sinks through the water column and is preserved in the sediments. The $\delta^{13}C_{org}$ of sediment trap samples ranged from -17.6 $^{o}/_{oo}$ to -22.6 $^{o}/_{oo}$ over the three year period. Three multi-cores were also analyzed for the $\delta^{13}C_{org}$ of sedimentary organic matter. The values $\delta^{13}C_{org}$ in core MC-2A, taken at 192 m water depth, ranged from -20.4 $^{o}/_{oo}$ to -18.2 $^{o}/_{oo}$, core MC-3A, taken at 354 m water depth, ranged from -19.7 $^{o}/_{oo}$ to 18.8 $^{o}/_{oo}$ and core MC-4A, taken at 432m water depth, ranged from -20.4 $^{o}/_{oo}$ to 19.1 $^{o}/_{oo}$. The $\delta^{13}C_{org}$ of sinking particles was positively correlated with CO_2 which is contrary to models constructed based on passive diffusion. Temperature and the $\delta^{13}C_{org}$ of sinking particles are highly correlated ($r^2 = 0.64$). The lowest integrated water column temperature (used as a proxy for intensity of upwelling) is inversely proportional to yearly integrated $\delta^{13}C_{org}$ values with highest (most enriched) $\delta^{13}C_{org}$ being associated with the years of the lowest temperature (strongest upwelling). Examination of the sediments show that there is an inverse relationship between alkenone derived temperature and the $\delta^{13}C_{org}$ values for the two deeper cores which are below the oxycline. We suggest that the $\delta^{13}C_{org}$ may be a proxy for strength of upwelling, although the mechanism for $\delta^{13}C_{org}$ enrichment during upwelling is not known.

B34A-05 1635h

Stable Carbon Isotopes Reveal Food Web Shifts due to Arctic Sea Ice Decline

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The decline in sea ice extent in the Arctic Ocean and its marginal seas since the 1950s has led to some documentation of, and even more speculation about, impacts on the arctic ecosystem. We used the stable carbon isotope signatures of primary producers, phytoplankton and sea ice algae, from the Beaufort Sea to examine relative shifts in the proportion of source carbon in biota and relate changes to sea ice conditions. Schell (2000), using del13C along baleen plates of bowhead whales as a time series proxy, proposed that the carrying capacity of the Western Arctic has declined by 30 to 40% over the past five decades. While this contention is not without challenge, it remains as the accepted paradigm to account for major ecological changes. However, McRoy et al. (2001), using seasonal nutrient depletions on the Bering Sea shelf for the past 20 years, found no decline in primary productivity. Using a simple mixing model of the two primary sources of carbon to whale diets we estimated the proportion of ice algae and phytoplankton in the food web. The data implicate a decline in the amount of ice algal carbon, rather than a decrease in ecosystem productivity, in the bowhead whale diet as an explanation for the trend in isotope values in baleen. The result correlates well with arctic sea ice extent over the period. Independent data from a productivity budget of the Bering Sea indicate that the heavy carbon signal from ice algae could increase the overall POM del13C by up to $2.5^{o}/_{oo}$, supporting the idea. Also, a 100-year time series of carbon isotopes in POM from a core in an anoxic bay in the Aleutian Islands correlates with sea ice extent, further supporting the view that proportions of source carbon in the ecosystem have changed.

B41A CC: 220 C-E Thursday 0830h

General Biogeochemistry Posters

Presiding: **N T Roulet,** McGill University**; T Moore,** McGill University

B41A-01 0830h POSTER

Sea Ice Biology in Polar Regions: State of the Art and Perspectives in the IPY

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Recent global warming in the Arctic Ocean predicts shifting of ice-edge to the north, decreasing of sea-ice thickness and surface, and increasing of ice-open areas. This scenario suggests increasing of biological productivity and duration of vegetation period, and intensification of regeneration processes in the sea ice-upper ocean system. However, at present the evidence of impacts of global change on the sea ice ecosystem is sparse or uncertain, though there are fragmentary indications of recent changes. As established now, the biological community response to global change is most likely in the regions, where the sea ice retreat is rather remarkable, e.g., in the region of Beaufort Gyre (Melnikov et al., 1998; Melnikov, 2000; Melnikov and Kolosova, 2001; Melnikov et al., 2001, 2002). Assessment of the recent sea-ice ecosystem dynamic and modeling its potential changes will allow us to estimate and forecast potential changes within the sea ice-upper water system and consequent ecological effects on higher trophic levels including birds, marine mammals and benthic organisms. Recently, one of the major ecological issues in polar regions is to figure out natural variations in the composition, structure and function of the marine ecosystems and variations due to anthropogenic factors. For example, overfishering of krill around Antarctic Peninsula in 70th was a reason in reconstruction of natural population structure in this region. In order to understand and distinguish both variations it is necessary to conduct a long-term ecological monitoring in the Southern Ocean (SO). This research will be the base of a predictive understanding of the Antarctic marine system, including its multiple modes of variability across timescales, its interaction with coastal systems, and its relationship with the global climate system. References 1. Melnikov I.A., Sheer B., Wheeler P., Welch B., 1998. Preliminary Biological and Chemical Oceanographic Evidence for the Long-Term Warming Trend in the Arctic Ocean (current materials of the SHEBA Ice Camp, Beaufort Sea). SEARCH Workshop, August, 1998. 2. Melnikov, I.A. 2000. The Arctic sea ice ecosystem and global warming. In: Huntington, H.P., (ed.). Impacts of changes in sea ice and other environmental parameters in the Arctic: final report of the Marine Mammal Commission Workshop, Girdwood, Alaska, 15-17 February 2000. Bethesda, Maryland: Marine Mammal Commission. 94-110. 3. Melnikov I.A., Zhitina L.S., Kolosova E.G. 2001. The Arctic Sea Ice Biological communities in recent environmental changes. In: Mem. Natl. Inst, Polar Res., Spec. Issue, 54: 409-416. 4. Melnikov I.F., Kolosova E.G. 2001. The Canada Basin zooplankton in recent environmental changes in the Arctic Ocean. In: Proceedings of the Arctic Regional Centre, v.3, 165-176. 5. Melnikov, I.A., L.G. Kolosova, H.E. Welch and L.S. Zhitina. 2002. Sea ice biological communities and nutrient dynamics in the Canadian Basin of the Arctic Ocean. Deep-Sea Research Part I, 49: 1623-1649.

B41A-02 0830h POSTER

Carbon Fluxes in Boreal Peatlands, La Grande Rivière Area, James Bay Lowlands, Québec, Canada

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As part of a large project on carbon dynamics in boreal peatlands, carbon dioxide and methane fluxes were measured in three peatlands in the La Grande Rivière area, James Bay lowland, Québec, Canada, between June and August 2003, and during one week in November 2003 and March 2004 (LG2 site only). The three sites studied correspond to the main peatland types present in the region (LG1, Rich Fen; LG2, Ombrotrophic Bog; LG3, Poor Fen). Measurements of CO_2 and CH_4 were made using static chambers on 20 collars in each peatland, 2 or 3 collars per ecological groups. A PP system infrared gas analyser was used for CO_2 measurements while CH_4 samples were analysed on a gas chromatograph. At each site, a weather station was installed to measure air temperature, relative humidity, precipitation, water table depth, PAR and peat temperature at 5, 10, 20 and 40cm depth. The objectives of this research are to determine the fluxes of CO_2 and CH_4 on the three sites and determine the relationships between the fluxes and water table depth, peat temperature and PAR obtained from the weather station. Preliminary results for CH_4 are between 1.43-120 mg m^{-2} d^{-1} (average 46.42 mg m^{-2} d^{-1}) for the LG1 site, 1.19-125 mg m^{-2} d^{-1} (average 39.69 mg m^{-2} d^{-1}) for the LG2 site and 2.68-300 mg m^{-2} d^{-1} (average 59.97 mg m^{-2} d^{-1}) for the LG3. There is a strong relationship between seasonal average water table depth and CH_4 flux.

B41A-03 0830h POSTER

Using In Situ Observations to Characterize Regional-Scale Patterns of Surface Albedo Across the North American Boreal Region

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The central role that land surface albedo plays in the physical climate system makes it a key component of climate and ecosystem models. However, this parameter remains one of the largest radiative uncertainties associated with modeling attempts. Uncertainty occurs because models commonly prescribe albedo using in situ observations, which are rarely sufficiently dense to accurately characterize albedo at a regional scale. This is especially problematic over seasonally snow-covered landscapes such as the boreal forest. The aims of this study are to (a) analyze and compare the local- and regional-scale albedo characteristics of the dominant land cover types found within the North American boreal region, (b) assess the the effects of snow cover on these patterns, and (c) quantify the potential bias that can result from using local-scale observations to describe surface albedos across larger geographical extents. Our study is based on local-scale in situ observations and regional-scale satellite (GOES) measurements that were collected as part of the Boreal Ecosystem-Atmosphere Study (BOREAS). Our results show (a) that the albedo patterns among land cover types are generally consistent at local and regional scales, (b) that snow cover not only increases the albedo of all cover types, but also their sensitivities to changes in solar zenith angle, and (c) that weekly-averaged in situ observations provide a reasonable characterization of regional-scale albedo when under snow-free conditions, but a poor characterization when snow is present. Land cover albedo characteristics are caused by canopy properties that influence within-canopy shadowing. The disparity between in situ albedo observations and those collected over low-density needleleaf forest are particularly a concern because this cover type comprises a significant proportion of the boreal region, and its misspecification in climate models could lead to large errors in energy balance. Further studies should focus on reducing the disparity between albedo datasets over snow-covered surfaces. They should also consider the effects of diffuse radiation, as well as finer time scales, on the above relationships.

B41A-04 0830h POSTER

Spatial Relationships in Local Net Ecosystem CO2 Exchange Among Representative Riparian and Land-use Types in a First Order, Agricultural Basin

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Recent studies have demonstrated the importance for quantifying CO2 exchange rates for all ecosystem components of the landscape. This work has shown that CO2 fluxes may be greater for relatively smaller land areas, such as riparian zones, and that their contribution to the total carbon (C) budget is substantially larger than previously expected. This potential source could be even greater for temperate riparian systems with shorter winter seasons and greater interseasonal variability. However, these previous investigations for temperate riparian areas are lacking due to logistical difficulties and time constraints of measuring distinct landscape units. This study was conducted the Strawberry Creek Watershed (SCW) a perennial, first order stream located in a small (3 km2) agricultural watershed in Maryhill, ON (15 km north of Waterloo, ON). The CO2 fluxes (NEE and respiration) were measured at least once a week from May 28 to September 11, 2003, using dynamic CO2 chambers and a portable Infa-red gas analyzer (IRGA). Simultaneously, climatic variables such as soil temperature, soil moisture and photosynthetically active radiation, and biotic factors, such as soil properties were evaluated. Further, to better understand the CO2 dynamics from field measurements, a lab incubation experiment was performed to assess the contribution of roots and soil towards the overall CO2 flux under varying soil temperature and moisture regimes. This paper illustrates the results of this study that aim to quantify and identify the growing season source/sink dynamics of various land-use types (riparian zones, open grassland fallow and maple woodlots) and their inherent environmental controls of surface (soil and vegetation) CO2 fluxes. Preliminary results suggest that soil temperature, at 5 cm depth, is the dominant mechanism controlling the temporal variability of CO2 emissions from both bare (belowground) and vegetated plots. However, this relationship seems to decouple during drought conditions. Furthermore, results indicate that long-term grass fallow sites may be substantial sources of carbon.

B41A-05 0830h POSTER

Relating Landscape, Vegetative, and Soil Characteristics With Net Nitrification Rates in Forested Watersheds

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Forested watersheds in the northeastern USA receiving similar levels of N deposition have exhibited different levels of stream nitrate export and different rates of soil nitrification. Recent isotope studies have demonstrated that stream water nitrate is isotopically similar to soil nitrate, suggesting that watershed soil nitrification rates directly influence watershed N loss. We are currently studying 10 watersheds in New Hampshire, New York, and Vermont in order to investigate correlations between watershed characteristics, soil properties, and soil nitrification rates. Watershed 24 hour nitrification rates seem to correlate well with stream nitrate export. Initial findings have shown positive relationships between higher nitrification rates and greater sugar maple abundance, low C:N, and lower amounts